Section 8 Results of Laboratory Analysis

8.1 Artifact Analysis

Only historic artifacts were documented in the 47 trenches (T-001 through T-047) excavated within the Airport Section 3 corridor (Table 11). The artifacts all likely date from the early- to mid-1900s, while two can be reliably dated as having been manufactured in 1942. The majority occurred in fill deposits while a few were found in a possible buried A-horizon lacking evidence of discrete features or midden.

The artifacts include two iron railroad spikes, ten pieces of rusted iron, several of which may be nails, and a single 11-cm wire nail (Figure 258). A few unidentifiable bottle glass fragments were found along with a brown bottle lip-neck fragment and two nearly whole bottles (see Figure 258). The lip-neck fragment and two bottles were manufactured in an automatic bottle machine (Lindsey 2010).

The two bottles exhibit manufacturing company marks indicating they were produced in 1942. One is a green hobble skirt Coca-Cola soda bottle (Figure 259). It was found in T-041, Stratum II, a local-derived fill deposit that also contained charcoal, slag, metal, bottle glass fragments, and concrete debris. The second is a clear beer bottle produced for filling by the Regal Amber Brewing Co., San Francisco (Figure 260). It was found in T-018, Stratum IIc, a fill deposit associated with military infrastructure build up of the area circa 1942-1943. Stratum IIc is identified as a component of SIHP # -7420 Feature 3.

Both bottles were manufactured by the Owens-Illinois Glass Company. This glass manufacturer marked most of their bottles from this period with a 2-mm embossed date code, a single- or double-digit number to the right of the Owens-Illinois mark (O and an I in a circle and a diamond) on the base, with the number “19” to the left of the mark and the number “42” to the right (Lockhart 2004).

The paucity of historic artifacts in the excavation trenches supports historical map data indicating the predominance of agricultural fields serviced by the plantation and the OR&L railroad lines prior to military development associated with World War II. It also supports the stratigraphic and historical evidence that the sediments imported for fill largely came from inland and/or nearshore areas characterized by minimal to no discard of historic structural, industrial, or domestic remains (e.g., building materials, household items, or food remains).

Table 11. Historic Artifacts Documented in the Airport Section 3 Test Excavations

Provenience	Description of Artifact	Comments
T-010, Str. II, 26-30 cmbs	4 highly oxidized metal fragments, possibly nails	11.2 g
T-018, Str. IIc, 170 cmbs	Complete clear bottle for Amber Brewing Co., San Francisco, Calif.; embossed mark for the Oakland, Calif. factory of the Owens-Illinois Glass Co. [O-I] on base, with date code for 1942; this brewery was called the Regal Amber Brewing Co. from 1935 to 1954 (Tavern Trove 2012; SHA/BLM 2013)	18 cm high x 6 cm in diameter; cylindrical, 2-piece cup mold, crown top, made in an Automatic Bottle Machine, white Applied Color Label for brand name; embossed on body “NO DEPOSIT NO RETURN – NOT TO BE REFILLED”; embossed on base “ 20 [O-I mark] 2/ Duraglas”
T-019, Str. Ic, 76-98 cmbs	Rail road spikes (2)	(Not collected)
T-029, Str. II, 107-135 cmbs	2 small glass fragments	Less than 0.1 g
T-031, Str. If, 30-43 cmbs	Clear glass fragments	Clear glass (not collected)
T-038, Str. II, 240-270 cmbs	Rusted metal piece	13.9 g
T-041, Str. Id, back dirt	Brown bottle lip and neck fragment	8.75 cm long, 2-piece mold, exterior threads on lip, made in an Automatic Bottle Machine
T-041, Str. Id, back dirt	Wire nail	11 cm long; wire nails were made after 1890
T-041, Str. II, 138-140 cmbs	3 rusted metal fragments	3.5 g
T-041, Str. II, 138-143 cmbs	2 small metal fragments	0.3 g
T-041, Str. II, 138-143 cmbs	Clear bottle, small body fragment	0.1 g
T-041, Str. II, 140 cmbs	Green hobble-skirt Coca-Cola bottle, neck to base fragment; embossed Owens-Illinois Glass Co. date mark on heel for 1942 (SHA/BLM 2013)	Cylindrical fragment 8.6 cm high and 5.5 in diameter
T-043, Str. If, 285-305 cmbs	Clear bottle, small body fragment	0.3 g

Figure 258. Brown alcohol bottle neck and wire nail from T-041 backdirt

Figure 259. Coca-Cola bottle (dating to 1942) from T-041 Stratum II

Figure 260. Regal Amber Brewing Co. Beer bottle (dating to 1942) from T-018 Stratum IIc

8.2 Faunal Analysis

The invertebrate and vertebrate faunal remains identified in 15 of the 47 test excavations are summarized in Table 12 and are described in detail below. This minimal assemblage consists primarily of trace or isolated remains from fill or natural deposits. No faunal remains of archaeological significance were identified.

8.2.1 Test Excavation 1 (T-001)

T-001, Stratum Ig (1.62-2.95 mbs), contained a single upper valve of a medium-sized *Chama iostoma* (rock oyster) weighing 33.2 g. *Chama iostoma* were collected as food. Titcomb (1979:350) describes elderly women diving for these rock oysters in Pearl Harbor and prizing their rich flavor. Because this shell was found as an isolate in a fill deposit, it cannot reliably be identified as cultural in origin.

8.2.2 Test Excavation 6 (T-006)

A 2.5 liter bulk sediment sample from T-006, Stratum II (1.62-1.75 mbs), yielded very small quantities of sea urchin spine (cf. *Echinometra mathaei*) (< 0.1 g) and unidentifiable marine shell fragments (< 0.1 g). These each were about 1 mm to 2 mm in length and highly fragmented. They likely are not cultural food remains due to their paucity and small size. Instead, their presence likely reflects natural processes (e.g., birds, tsunami, hurricane, pyroclastic events blasting up through shallow reefs, etc.). This interpretation is further supported by the identification of Stratum II as a natural deposit with no evidence of features or artifacts.

8.2.3 Test Excavation 10 (T-010)

A 35 liter screened sediment sample from T-010, Stratum II (0.26-0.30 mbs), yielded two fragments of bivalvia. One is reported to be *Pinctada radiata* (1.3 g) and the other is unidentified bivalvia (0.7 g). Their presence along with four highly oxidized metal fragments (most likely iron nails) suggest Stratum II may represent a former A-horizon.

8.2.4 Test Excavation 18 (T-018)

T-018, Stratum III (2.40 mbs), contained an unidentified bivalve fragment (< 0.1 g). The invertebrate remain likely is natural. It was found in a natural terrigenous clay deposit below several fill layers and SIHP # -7420, Feature 3 paving (Stratum IIa), curbing (Stratum IIb), and underlying fill (Stratum IIc).

8.2.5 Test Excavation 21 (T-021)

A 1 liter bulk sediment sample from T-021, Stratum III (1.10-1.20 mbs), yielded fragmentary unidentified bivalvia (< 0.1 g) and miscellaneous unidentified marine shell (< 0.1 g). These invertebrate remains likely are natural. They were found in a natural clay deposit below several fill layers and the SIHP # -7420, Feature 3 coral pavement (Stratum IIa) and underlying base course (Stratum IIb).

8.2.6 Test Excavation 27 (T-027)

A 1 liter bulk sediment sample from T-027, Stratum III (2.29-2.49 mbs), yielded < 0.1 g of fragmentary marine gastropods (*Turbo sandwicensis* and *Hipponix* sp.) and < 0.1 g of fragmentary unidentified bivalvia. These invertebrate remains likely are natural. They were

Table 12. Airport Section 3 Faunal Remains

Provenience	Cow	Pig	Sheep	Fish	Bivalve	Gastropod	Unidentified shell	Echinoderm (sea urchin)	Crustacean (crab claw)
T-001*, Str. Ig, 162-295 cmbs					33.2 g (rock oyster)				
T-006*, Str. II, 162-175 cmbs							< 0.1 g	< 0.1 g (*Echinometra mathaei*)	
T-010, Str. II, 26-30 cmbs					1.3 g (*Pinctada radiate*); 0.7 g (n/a)				
T-018*, Str. III, 240 cmbs					< 0.1 g				
T-021*, Str. III, 110-120 cmbs					< 0.1 g		< 0.1 g		
T-027*, Str. III, 229-249 cmbs					< 0.1 g	< 0.1 g (*Turbo sandwichensis* & *Hipponix sp.*)	< 0.1 g		
T-030*, Str. Ib, 40 cmbs			6.1 g (femur)						
T-030*, Utility Pit, 0-40 cmbs		4.8 g (rib)							
T-033*, Str. Ie, 45 cmbs	31.3 g (rib)								

Provenience	Cow	Pig	Sheep	Fish	Bivalve	Gastropod	Unidentified shell	Echinoderm (sea urchin)	Crustacean (crab claw)
T-034, Str. II, 85-126 cmbs				< 0.1 g					
T-035*, Str. II, 145-173 cmsb					< 0.1 g (*Brachidontes crebristriatus*)		< 0.1 g		
T-038*, Str. II, 258-270 cmbs					< 0.1 g (*Brachidontes crebristriatus*)		< 0.1 g	< 0.1 g (*Echinometra mathaei*)	< 0.1 g
T-038, Str. II 259-269 cmbs				0.6 g	0.8 g (*Brachidontes crebristriatus* and *Tellina palatum*)	7.6 g (*Melampus*, *Nerita*, *Turbo*, *Trochus, & Hipponix*)		< 0.1 g (*Diadema paucispina*)	
T-039, Str. IIa, 165-175 cmbs				1.5 g	< 0.1 g (*Brachidontes crebristriatus*)				
T-041*, Str. II, 140-150 cmbs					0.3 g (*Brachidontes crebristriatus*)	1.2 g (*Turbo*)			
T-043*, Str. Ig, 285-305 cmbs						11.0 g (*Cerithium, Turbo, Trochus*)			
T-044, Str. Ic, 60-138 cmbs					82.9 g, (*Chama fibula*); 11.1 g (*Arcidae barbatia*)	11.3 g (*Prodotia*)			
Total	31.3 g	4.8 g	6.1 g	< 2.2 g	< 130.9 g	< 31.2 g	< 0.5 g	< 0.3 g	< 0.1 g

*Regarded as naturally-deposited

found in a natural silty clay loam deposit below multiple fills, including several containing fragmentary marine shell and/or coral.

8.2.7 Test Excavation 30 (T-030)

T-030, Stratum Ib (0.40 mbs), contained a sheep (*Ovis aries*) femoral portion (6.1 g) that exhibited cut marks characteristic of butchering. A second bone was found in an infilled modern utility trench (0-0.40 mbs) that was intrusive through Stratum Ia into the upper portion of Stratum Ib. It consists of a pig (*Sus scrofa*) rib fragment (4.8 g) that exhibited cut marks characteristic of butchering. The source of the trench fill remains unknown. These historic or modern food bones were found in upper fill deposits identified as being from mixed origin.

8.2.8 Test Excavation 33 (T-033)

T-033, Stratum Ie (0.45 mbs), contained a cow (*Bos taurus*) rib fragment (31.3 g) that exhibited cut marks characteristic of butchering. This historic or modern food bone was found in a fill deposit overlying a natural clay loam (Stratum II). The source of this fill remains unknown.

8.2.9 Test Excavation 34 (T-034)

T-034, Stratum II (0.85-1.26 mbs), contained a small unidentified fish bone (< 0.1 g). The fish bone was found in an undisturbed natural clay loam deposit below a modern fill deposit (Stratum Ic). No other faunal remains were observed, suggesting this isolated fish bone is not cultural in origin.

8.2.10 Test Excavation 35 (T-035)

A 1 liter bulk sediment sample from T-035, Stratum II (1.45-1.73 mbs), yielded < 0.1 g of fragmentary mollusk remains including *Brachidontes crebristriatus*. These invertebrate remains likely are natural. The remains were found in a natural silty clay deposit above the coral bedrock. No other faunal remains were observed within this deposit.

8.2.11 Test Excavation 38 (T-038)

A 1.5 liter bulk sediment sample from T-038 Stratum II (2.60-2.70 mbs), yielded very small quantities of fragmentary bivalvia including *Brachidontes crebristriatus*, unidentified mollusk, sea urchin (cf. *Echinometra mathaei*) and a crab claw (< 0.1 g each).

A 2 liter bulk sediment sample from collected from the backhoe bucket of T-038 Stratum II (2.59-2.69 mbs) yielded 8.5 g of gastropoda including *Melampus sp.*, *Nerita picea*, *Turbo sandwicensis*, *Trochus intextus*, *Hipponix* sp., 0.8 g of bivalve including *Brachidontes crebristriatus*, *Tellina palatum*, and < 0.1 g sea urchin (*Diadema paucispina*), and 0.6 g of unidentifiable fish bone.

Whether these invertebrate remains and isolated unidentifiable fish bone from these two samples are related to a former midden deposit is uncertain. They were found below the water table in a gley deposit of mixed origin, which also contained historic and/or modern sugar cane, slag, and a piece of wood. In addition, it is possible that contamination may have occurred as a result of sampling from the backhoe bucket.

8.2.12 Test Excavation 39 (T-039)

A 2 liter bulk sediment sample from T-039, Stratum IIa (1.65-1.75 mbs), yielded < 0.1 g of marine shell including *Brachidontes crebristriatus* and a particularly large fish vertebra (1.5 g). These two remains were found in a natural silty clay deposit.

8.2.13 Test Excavation 41 (T-041)

A 10-liter screened sediment sample from T-041, Stratum II (1.40-1.50 mbs), yielded 1.5 g of shell including *Turbo sandwicensis* and *Brachidontes crebristriatus*. These invertebrate remains were found in a natural clay deposit and locally-derived fill that also included charcoal, slag, and bottle glass. As the marine shell was not observed within a distinct midden feature, it remains unknown whether they reflect human consumption and discard or a natural deposition.

8.2.14 Test Excavation 43 (T-043)

A 1 liter bulk sediment sample from T-043, Stratum Ig (2.85-3.05 mbs), yielded 11.0 g of highly fragmentary shell including *Cerithium* sp., *Turbo sandwicensis*, and *Trochus intextus.* These remains were found in a fill deposit of mixed origin that also included a clear bottle glass fragment.

8.2.15 Test Excavation 44 (T-044)

T-044, Stratum Ic (0.60-1.38 mbs), yielded three relatively large and uncommon marine shells. These consisted of gastropod *Prodotia ignia* (11.3 g) and the bivalves *Chama fibula* (82.9 g) and *Arcidae barbatia* (11.1 g). The remains were found in a 1.73 m thick fill layer of silty fine sand.

8.3 Summary Remarks Regarding the Airport Section 3 Midden

The invertebrate and vertebrate faunal remains collected from 15 excavation trenches within the Airport Section 3 corridor are not archaeologically significant. None of the remains occurred in a discrete cultural deposit (e.g., midden concentrations, fire pits, or similar contexts). Most occurred in fill layers such as dredged reclamation fills. Others appeared in disturbed natural deposits, including gley sediments and/or in association with historic cane slag, wood, and/or bottle glass. With the exception of several fish bones, the vertebrate remains consisted of historic or modern butchered fragments of pig, cow, and sheep. No bird bone was identified. In fact, the absence of faunal remains that could reliably be identified as being from an *in situ* habitation of midden location supports the historical data indicating an absence of LCAs and/or Hawaiian habitations in the corridor vicinity.

8.4 Pollen Analysis

The samples submitted for pollen analysis from test excavations in the Airport Section 3 study area are described in detail in Linda Scott Cummings' report titled *Pollen Analysis from the Honolulu High-Capacity Transit Corridor Project* (Appendix F). A broad overview of pollen studies is presented here from similar studies within a shared geographic context.

8.4.1 Previous Pollen Studies

Presented below are the results of eight previous pollen studies conducted between 1991 and 2002 within the vicinity of the Airport Section 3 study area (see Figure 261 and Figure 262 for the locations of ptrevious pollen studies in the vicinity).

8.4.1.1 Wickler et al. 1991

The International Archaeological Research Institute, Inc. conducted palynological studies in association with a Fort Shafter Flats sewer line project. Seven pollen samples were collected from a Profile 1 area and six from a Profile 10 area. At least 84 species or types belonging to 49 families were represented (Wickler et al. 1991:37). Despite this diversity only one Polynesian introduced plant was documented (*Aleurites moluccana, kukui*). The study concluded:

> …one conclusion is firm: the picture of a lowland Pritchardia (loulu) forest with a high diversity of dryland to mesic forest types offers a new level of understanding of the pre-contact natural lowland vegetation, very different from the vegetation seen today or even during the period represented by Pollen Zone A around A.D. 768-997. (Wickler et al. 1991:51)

In the oldest sediments *Pritchardia* pollen remains quite constant accounting for 27% to 28% of the pollen but by the A.D. 768-997 sample it drops to 2%.

8.4.1.2 Avery et al. 1994

Archaeological Consultants of Hawai‘i, Inc. conducted palynological analyses as part of archaeological monitoring of an electric utility line project along Kamehameha Highway. The pollen sample was from a locale on the west (*makai*) side of the highway about 210 m south of the mouth of Hālawa Stream. Seven pollen samples were analyzed from a single borehole (Bore Hole #39). Data from one sample corresponded to a radiocarbon date reported as A.D. 890-1294 (Avery et al. 1994). The inferences from the pollen study are presented in Table 13.

The study posits that while there was a “pre-Polynesian, gradual, decline in the *Pritchardia* record, it is certain that around, or shortly after, AD 890-1294 there was a catastrophic decline in the palm forest” (Avery et al. 1994:55-56).

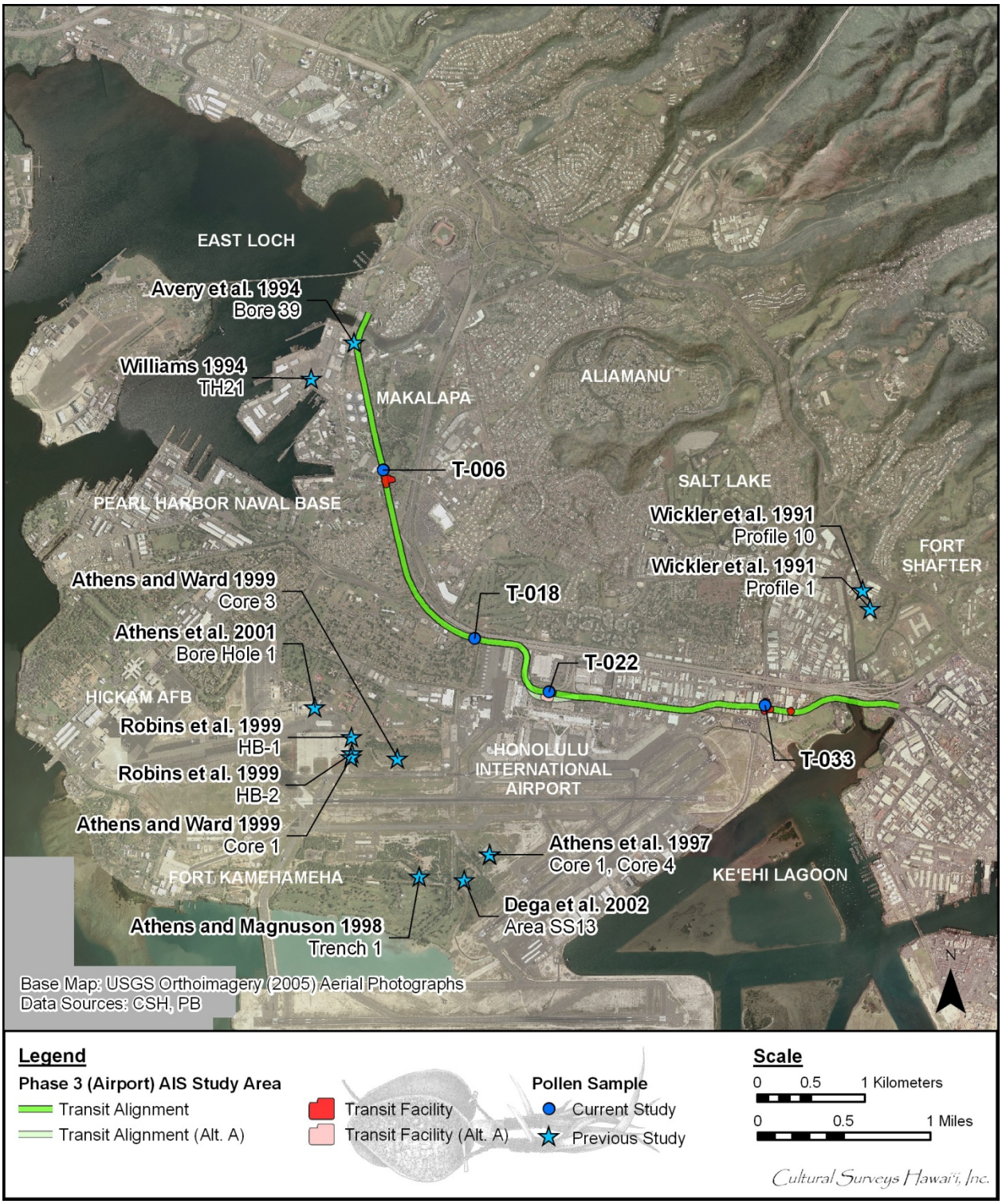


Figure 261. Aerial orthophotograph showing relationship of prior pollen study areas to the present pollen sampling locations

Figure 262. 1933 U.S. Army War Department Fire Control map showing relationship of prior pollen study areas to former fishponds and the present pollen sampling locations

Table 13. Inferences from Pollen Study at the Mouth of Hālawa Stream (Avery et al. 1994:50)

Zones of Pollen Record	Timeframe indicated from 14C	Characterization
“Zone B”	[Relating to R1 reported date of A.D. 890-1294]	“..exhibited a dramatic increase in the presence of sedges and grasses, perhaps representing the development of marshy conditions locally, and of open environments inland, respectively.”
“Zone A2”	4,000 to 1,700 BP	“…essentially similar to A1, although there was a marked increase in the presence of pteridophytes which suggested a more open forest cover.”
“Zone A1	4,000 BP	“Dry-mesic forest, trees and shrubs… dominated by *loulu* (*Pritchardia* sp.) pollen.”

8.4.1.3 Williams 1994

Ogden Environmental and Energy Services Co. Inc. conducted palynological analysis in the course of their subsurface archaeological investigations in support of subsurface fuel investigations in the vicinity of the former Kunana Fishpond in the area just 100 m northeast of Magazine Loch of the Pearl Harbor Naval Base. Five pollen samples were analyzed from one auger core. There was a problem of modern *kiawe* (*Prosopis pallida*) pollen contamination in pre-Contact strata (Williams 1994:A-2). The indicated pattern was of an abundance of Poaceae grass pollen in pre- or early Polynesian times (under an overlying C14 date of AD 372-796). Later, circa AD 974-1435 and 1298–1428, the pollen of shrubs and trees increased. This is somewhat counter-intuitive as the general trend is understood as forest changing to grass land in response to human settlement, but is explained as clearing of Poaceae grasses from around the fishpond during fishpond construction and use (Williams 1994:A-3). The most recent sample (post-dating AD 1307-1668) indicated a change with “a much larger Poaceae pollen frequency [which] suggests that at this time the pond was filling in with vegetation including primarily grasses, and may or may not have been used as an active fishpond” (Williams 1994:A-3).

8.4.1.4 Athens et al. 1997

The International Archaeological Research Institute conducted a data recovery program for a Terminal Radar Approach Control (TRACON expansion project at the west end of Honolulu International Airport within the former Hickam Air Force Base (now a part of JBPHH). The data recovery program was undertaken to mitigate possible adverse impacts to the former Ka‘ihikapu Fishpond (SIHP # 50-80-13-0081). This data recovery included pollen analysis from two cores. In both cores “the profile appears to show inverted stratigraphy” (Athens et al. 1997:40) with native forest in the upper sample including *Pritchardia (loulu)*, *Kanaloa kahoolawensis*, *Acacia koa* (*koa*), etc., and exotic introductions (*Batis maritima* or pickleweed, *Casuarina equisetifolia* or ironwood, *Prosopis pallida* or *kiawe*) in the lower sample.

Three Polynesian-introduced species were detected: *kukui* (*Aleurites moluccana*), *niu* or coconut (*Cocos nucifera*) and ti or *kī* (*Cordyline fruticosa*). The authors reasonably conclude (Athens et al. 1997:42) that the upper sediments consist of fill (with relatively older pollen) that

was superimposed on sediments that had been exposed to modern pollen types. It seems probable that the fill was procured from a neighboring locale but we really do not know. Because of the inversions and the fact that the pollen is not *in situ*, inferences are limited.

8.4.1.5 Athens and Magnuson 1998

The International Archaeological Research Institute, Inc. conducted an archaeological subsurface survey in support of a low level wind shear alert system relocation project within the south central portion of the former Hickam Air Force Base (now JBPHH) near the former Loko Ka‘ihikapu Fishpond. Two samples from Trench 1 were analyzed. Disturbance or mixing was indicated in both samples (Athens and Magnuson 1998:17). Both samples may be historic (Athens and Magnuson 1998:iii).

8.4.1.6 Athens and Ward 1999b

The International Archaeological Research Institute, Inc conducted paleoenvironmental coring at the former *loko* Lelepaua fishpond about 1.3 km southwest of the Airport Section 3 alignment. Two cores were recovered. Fishpond sediments were not documented and “both cores contained inverted stratigraphy, with possibly intact (undisturbed) historic-period deposits overlain by sediments apparently pertaining to the prehistoric Polynesian period.” (Athens and Ward 1999b:iii) The overlaying sediments (including the older pollen) were interpreted as fill.

The authors concluded that an earlier pre-Contact period:

> is characterized by a mixed dry lowland forest community possibly dominated by *Pritchardia* palms with common *Chamaesyce*, *Dodonaea viscosa*, *Kanaloa kahoolawensis*, and with *Cibotium* and several other ferns. The late prehistoric period is characterized by a decline in the frequency of native taxa, higher counts of cheno-ams and grass, and the presence of Polynesian introductions (*Aleurites* and *Coco*). (Athens and Ward 1999b:iii)

8.4.1.7 Robbins et al. 1999

Ogden Environmental and Energy Services Co. Inc. conducted palynological analysis in the course of their archaeological monitoring and sampling during excavations for an AMC (Air Mobility Command) Ramp Lighting project in the central portion of the former Hickam Air Force Base (now a part of JBPHH) within what appears to be the former location of Lelepaua Fishpond. Four sediment samples were analyzed (one from Hole Boring-1 and three from Hole Boring-2).

The study notes:

> About 26 endemic plants (trees, shrubs, and herbs) are represented in the identified pollen from the samples. Of these, eleven are trees that include eight identified genera (*Acacia*, *Anlidesma*, *Bobea*, *Clermontia*, *Myrsine*, *Eugenia*, *Pritchardia*, and *Psycholria*), and three identified families (Myrtaceae, Araliaceae and Xanthoxylum). An increase in *Pritchardia* pollen (the endemic *1o‘ulu* palm) from Layer VIII to Layer Vc was noted in the samples. The endemic shrubs are represented by eight identified genera, including *Broussaisia*, *Euphorbia*, *Erythrina*, *Vida*, *Hedyolis*, *Labordia*, *Scaevola*, and *Solanum*. Herbaceous endemics are represented by five genera, including *Bonamia*, *Schiedea*-type,

> *Lepidium*, *Cuscula*, and *Viola*, and two identified families (Apiaceae and Asteraceae).
>
> Five Polynesian introduced plants are represented in the identified pollen, including two trees and two shrubs and a member of the family Liliaceae. Pollen identified as coconut (*Cocos nucifera*) was recovered from Layer VIII, and pollen grains from the family Myrtaceae (Myrtle family) were found in all of the samples. One of the shrubs, identified as a member of the Fabaceae family (legume or pea family) was also represented in all of the submitted samples. Pollen identified as a type similar to *Piper methysticum*, or *awa*, was recovered from Layer VlIg. Layer Vc was the only sample containing ti (*Cordyline* spp., kī*),* a member of the Liliaceae family. (Robbins et al. 1999:39)

The study concludes:

> The results of the pollen analysis tend to support the radiocarbon date from Layer VIII. The presence in this layer of pollen grains from Polynesian-introduced plants such as *Cocos nucifera* (coconut tree), and unidentified members of the Myrtaceae and Fabaceae families, suggests these introduced plants were at least starting to be established by Hawaiians settling near (inland and possibly adjacent to) this pond during the formation of Layer VIII (tentatively dated to circa A.D. 1275-1425).
>
> This study notes: “The general pattern seen in the pollen recovery that indicates a change in vegetation from a more open habitat to one that recently supported more shrubs and trees…” This is somewhat counter intuitive as the generally understood pattern is that human settlement and use of fire transformed woodlands into grass lands.
>
> It is suggested that this: “can be interpreted as indirect evidence of a cycle of inland erosion and subsequent deposition of sediments in the coastal areas. An increase in sediments in the coastal areas would tend to encourage more plant growth. It is suggested that the availability of such sediments in the inland areas may be linked to traditional agricultural practices in upland forested areas (e.g. slash and bum technique). (Robbins et al. 1999:42)

An inversion in the C14 dates obtained (Robbins et al. 1999:43) suggests the use of caution in detailed interpretation.

8.4.1.8 Athens et al. 2001

The International Archaeological Research Institute, Inc conducted paleo-environmental coring at a “Tank 2” location in the central portion of the former Hickam Air Force Base (now a part of JBPHH) within the former location of Lelepaua Fishpond. Six pollen samples from Core 1 were processed. Various inconsistencies in the data led to the conclusion that: “the Tank 2 sediment column consists almost entirely of fill” (Athens et al. 2001:ii) which limits inferences.

8.4.1.9 Dega et al. 2002

In the course of archaeological monitoring and sampling associated with subsurface groundwater plume investigations Scientific Consultant Services conducted a palynological

study within the central portion of the former Hickam Air Force Base (now a part of JBPHH) within the former location of Ka‘ihikapu Fishpond. Four samples from one soil core was analyzed. Significant contamination of the record was indicated as the historically introduced *Batis maritime* pickleweed pollen was “very abundant” in the deepest sample “signaling the presence of historic sediment and organic debris at depth” (Dega et al. 2002:31). As “all samples appeared to have experienced mixing” (Dega et al. 2002:32) inferences are limited.

8.4.2 Pollen Results from the Present Study

Most pollen studies in the vicinity of the Airport Section 3 study area have targeted the location of former fishponds which, if undisturbed, should be ideal locations for pollen preservation and stratification. Deep, stratified, undisturbed, fine sediments in a depositional environment are the most ideal for pollen studies. These criteria were seldom present along the Airport Section 3 corridor. Pollen analysis was conducted on samples from four test excavations in the study area, the results include a summation of the possible environmental reconstruction for the areas and are presented below. Pollen samples were taken from natural, relatively-undisturbed sediments. Locations were selected based on field evaluations of the likelihood of sampling locations providing information on former environments. The goal was a modest effort to develop data on prior vegetation and land use given the inherent constraints of the project area.

Table 14. Summary of Pollen Samples

Provenience	Comment
T-006, Str. II, 162-175 cmbs	*Myrsine, kōlea, and* sedges pollen supports riparian environment
T-018, Str. III, 250 cmbs	Relatively dry habitat indicated. Evidence of burning of weeds
T-022, Str. II, 150 cmbs and 200 cmbs	Many native shrubs and tree present but also exotic tree pollen, *Gossypium*-type pollen and *Oryza*-type pollen
T-033, Str. II, 130 cmbs	Relatively dry habitat indicated. *Gossypium*-type pollen and *Oryza*-type pollen present.

8.4.2.1 Test Excavation 6 (T-006)

T-006 was located in a road cut on the northern side of Kamehameha Highway. Historic maps indicate that this location lies near the former Wailolowai rivulet or water course. The collected sediment sample consisted of cobbles and stones embedded in a silty clay loam. Because of safety constraints a bulk sediment sample was carefully recovered with a backhoe bucket and was considered viable to submit for pollen analysis. The bulk sediment sample was from Stratum II between 1.62-1.75 mbs. The sample yielded small quantities of *Myrsine* and Cyperaceae pollen (Figure 2, Table 2, and 3), which represented the growth of *kōlea* and sedges combined with the presence of cobbles and stones. The results generally conformed to the remnants of Wailolowai Stream. Cobbles and stones are indicative of relatively fast moving water. Water that flows swiftly usually transports pollen to downstream locations. When the water subsides the smaller particles, including pollen, drop to the sediments. In this case it is likely that a sedge marsh was located along the banks or in the floodplain of the Wailolowai rivulet and that the

water course is represented in the pollen assemblage within the Stratum II sample submitted for pollen analysis.

8.4.2.2 Test Excavation 18 (T-018)

T-018 was collected in the sidewalk area of Nimitz Highway. The collected sediment consisted of clay overlying volcanic tuff. Because of safety constraints the bulk sample was carefully recovered with a backhoe bucket and was considered viable to submit for pollen analysis. The bulk sediment sample was from a depth of about 2.40 m in Stratum II. Pollen recovered from this sample was dominated by High-spine Asteraceae pollen, representing an abundance of plants in the sunflower family growing locally. Plants of the sunflower family often colonize disturbed soils and suggest disturbed sediment. Moderate to small quantities of Chenoam and Poaceae pollen were noted in this sample, representing *‘aheahea*, which grows in relatively dry habitats. Small quantities of *Sida*, *Waltheria*, Liguliflorae, *Boerhavia*-type, Cyperaceae, *Euphorbia*, and *Perispermum* pollen indicate that local vegetation also included *‘ilima*, *‘ulaloa*, *alena*, sedges, spurge, and bonamia. Ferns are also well represented in this record. A moderately large quantity of charred Asteraceae fragments and a small quantity of charred Poaceae (grass) fragments suggesting burning weeds, many of which were members of the sunflower family. There is no evidence of agricultural activity in this sample. Total pollen concentration was moderately low at about 1260 pollen per cc of sediment.

8.4.2.3 Test Excavation 22 (T-022)

T-022 was located within the Honolulu International Airport economy parking lot. The collected sediment sample consisted of a silty clay loam exhibiting charcoal or black organic stains. Two samples were collected with a trowel from depths between 1.50 and 2.00 mbs in Stratum II. No pollen taxon dominated the record in either of these samples. Resuts yielded moderately small quantities of Cheno-am, *Sida*, High-spine Asteraceae, Liguliflorae, and Poaceae pollen reflect local vegetation that included moderate quantities of *‘aheahea*, *‘ilima*, members of the sunflower family, and grasses. A few trees are represented by *Acacia*, *Cocos nucifera*, *Myrsine*, *Pandanus*, and *Pritchardia* pollen indicating local growth of *koa*, coconut, *kōlea*, *hala*, and *loulu* palm. A pore was visible in one of the *Pandanus* pollen, which is necessary to substantiate a distinction between *Pandanus* and *Colocasia* pollen, since they are of similar size and morphology. Additional shrubby vegetation is represented by small quantities of *Broussaisia*, *Hibiscus*, *Plumbago*-type, *Vitex*-type, and *Waltheria* pollen indicating growth of *kanawao*, *hau*, *‘ilie‘e*, *kolokolo*, and *‘uhaloa*. Invasive trees are represented by moderate to small quantities of *Leucaena* and *Prosopis* pollen, indicating *koa haole* and *kiawe* growing in the area. Both of the samples contained *Gossypium*-type pollen, suggesting cultivating cotton in the area, possibly in a field at this location. *Gossypium* pollen is noted to travel for several miles by wind dispersal, so locating the agricultural field using *Gossypium* pollen may mean examining many trenches within a transect. Further, large grass pollen, typical of that produced by *Oryza* (rice) was noted in these two samples. The upper sample contained an abundance of burned or charred Poaceae (grass) fragments, suggesting periodic burning of fields that most likely contained rice. Both samples also exhibited smaller quantities of Asteraceae charcoal, indicating that members of the sunflower family probably grew as weeds and were burned when the fields were burned. Moderately large quantities of fern spores were observed in these samples, indicating a substantial fern population growing in the area. The Total pollen concentration was very similar

in both samples at slightly more than 1200 and slightly less than 1300 pollen per cc of sediment in the lower and upper samples, respectively.

8.4.2.4 Test Excavation 33 (T-033)

T-033 was excavated within the Pacific Courier parking lot on the northeast (*mauka*/Diamond Head) corner of Lagoon Drive and Waiwai Loop. A 2.5 liter bulk sediment sample was collected from II, between 1.28-1.39 mbs, and consisted of a silty clay loam with charcoal flecking. A portion of the sample was analyzed for pollen content, and the sample was dominated by Cheno-am pollen, probably reflecting primarily *Chenopodium oahuense* (*‘aheahea*). These shrubs prefer drier habitats. Small quantities of *Acacia*, *Anacardiaceae*, *Cocos nucifera*, *Myrtaceae*, *Pittosporum*, and *Pritchardia* pollen were noted, representing trees including *koa*, a member of the sumac family, coconut, a member of the myrtle family, *ho‘awa*, and *loulu* palm, suggesting the presence of trees typically associated with a coastal location. Pollen indicating shrubby vegetation includes *Broussaisia* and *Waltheria* in addition to Cheno-am representing *kanawao* and *‘uhaloa*. Small quantities of Low-spine Asteraceae, High-spine Asteraceae, Cyperaceae, and *Euphorbia* pollen indicate that members of the sunflower family, sedges, and spurge also grew locally. Small to moderate quantities of *Leucaena* and *Prosopis* pollen represent *koa haole* and *kiawe* growing in this area. *Gossypium* pollen was present, but in a smaller quantity than was observed in T-022, possibly indicating that cotton grew farther from this location. The sample also yielded a moderate quantity of *Oryza*-type pollen. According to the Donn 1906 Map, a wetland agriculture area was approximated to be located northwest of this location (see Figure 98). Ferns are represented by a few spores. Charred sunflower family fragments were recovered, but charred Poaceae (grass) family fragments were not. The total pollen concentration was moderately high at about 8500 pollen per cc of sediment, which is more typical of a wetland than a dry deposit.

8.4.3 Summary of Pollen Analysis

Regrettably for paleo-environmental reconstruction the Airport Section 3 simply lacks valid depositional environments as may yield well-stratified pollen records to inform on environmental change over time. A modest effort was made to gain pollen data as may inform on former environments and land use as appropriate for the sampling opportunities present. The only superimposed pollen sample presented here was from T-022 and it is uncertain regarding the time depth indicated. The presence of what appears to be rice (*Oryza*-type) pollen in the lower sample suggests they both may be nearly contemporaneous and historic in age.

The sedge pollen from T-006 supports the inference from the water-rounded tuff pebbles present in the test excavation that flowing water was present in this area. This is also suggested in the Lyons 1873 map (see Figure 94). Other than in this T-006 area, the pollen data is dominated by dryland or mesic species (see Table 15 and Table 16) including several that are well-known and would be expected such as *Sida* (*‘ilima*) *Waltheria* (*‘uhaloa*), and *Vitex* (*pōhinahina*) but also seemingly including *kōlea* (Myrsine), *ho‘awa* (Pittosporum), *kanawao* (*Broussaisia arguta*), and *‘aweoweo* (Chenopodium).

Table 15. Pollen Taxa Identified from the Airport Section 3 Corridor

Scientific Name	Common Name	Nat	Pol	End	Ind
Trees:					
Acacia	*Koa, kolu, koai‘e*	x		x	
Anacardiaceae	Mango family	x		x	
Cocos nucifera	*Coconut, niu, alolani*		x		
Myrsine	*Myrsine, Ōliko, Kōlea lau nui, Kōlea lau li‘i*			x	
Myrtaceae	Myrtle family	x	x	x	x
Pandanus tectorus	*Hala, pū hala*				x
Pittosporum	*Ho‘awa, ha‘awa*	x		x	
Pritchardia	*Loulu* palm, *Loulu hiwa*			x	
Shrubs:					
Broussaisia arguta	*Kanawao, pū‘ahanui*			x	
Chenopodium	Goosefoot, pigweed, lamb’s quarters, Mexican tea, worm seed, *‘aheahea*, *‘ahea*, *‘ahewahewa, alaweo, alaweo huna, ‘aweoweo, kaha‘iha‘i*	x		x	
Cheno-am	Achyranthes, *Chenopodium oahuense*, Amaranthus, Charpentiera, etc.	x		x	
Cressa	Cressa				x
Euphorbia (shrub or herb)	*Kaliko*, spurge, Mexican fireplant (wild poinsettia)	x		x	
Hibiscus	*Aloalo, hau, koki‘o, ke‘oke‘o, (hau hele, koki‘o kea, pamakani), ma‘o hau hele, kaiohala (akiahala, hau hele wai), koki‘o (mākū),* large leaved *hau*, cotton or confederate rose (*aloalo waikāhuli, waikāhuli*)	x		x	x

Scientific Name	Common Name	Nat	Pol	End	Ind
Plumbago	*Ilie‘e, hilie‘e*				x
Sida	*‘ilima*, Prickly sida	x			x
Vitex	*Kolokolo kahakai, hinahina kolo, mānawanawa, māwanawana, pōhinahina, pōlinalina*, beach vitex				x
Waltheria	*‘Uhaloa* (*‘ala‘ala pū loa*)				x?
Herbs:					
Low-spine Asteraceae	Sunflower family; includes ragweed and others	x		x	x
High-spine Asteraceae	Sunflower family; includes *Bidens*	x		x	x
Liguliflorae	Sunflower family, chicory tribe	x			
Boerhavia	*Alena, anena, nena*	x			x
Bonamia menziesii (Perispermum)	*None* (Vine in dry to mesic forest)			x	
Cleome	Spider plant, spider flower, spider wisp, *honohina, ‘ili‘ohu, honohino*	x			x?
Polygonum sp.	Knotweed/smartweed	x			
Stenogyne	*Pua‘ainaka, Ma‘ohi‘ohi, Mohini*			x	
Grasses, etc.:					
Cyperaceae	Sedge family	x		x	x
Poaceae	Grass family	x		x	x
Typha	Cattail	x			
Cultigens:					
Gossypium tomentosum	*Ma‘o, huluhulu*, native cotton			x	
Oryza	Rice	x			
Vigna	*Mohihihi, nanea,* beach pea			x	x
Introduced:					

Scientific Name	Common Name	Nat	Pol	End	Ind
Leucaena	*Koa-haole (‘ekoa, lilikoa*)	x			
Prosopis	*Kiawe*, mesquite	x			
Indeterminate	Too badly deteriorated to identify				
Spores:					
Dicksoniaceae	Tree fern family			x	x
Lycopodium cernuum	Club moss (*Wiwae‘iole*)			x	
Monolete	Fern				
Trilete	Fern				
Other:					
Starch angular	Grass seed-type starch				
Foraminifera	Forams				
Scolecodont	Polychaet worm jaw				
Microscopic charcoal	Microscopic charcoal				
Charred Asteraceae fragments	Charred pieces of a member of the sunflower family				
Charred Poaceae fragments	Charred pieces of grass				

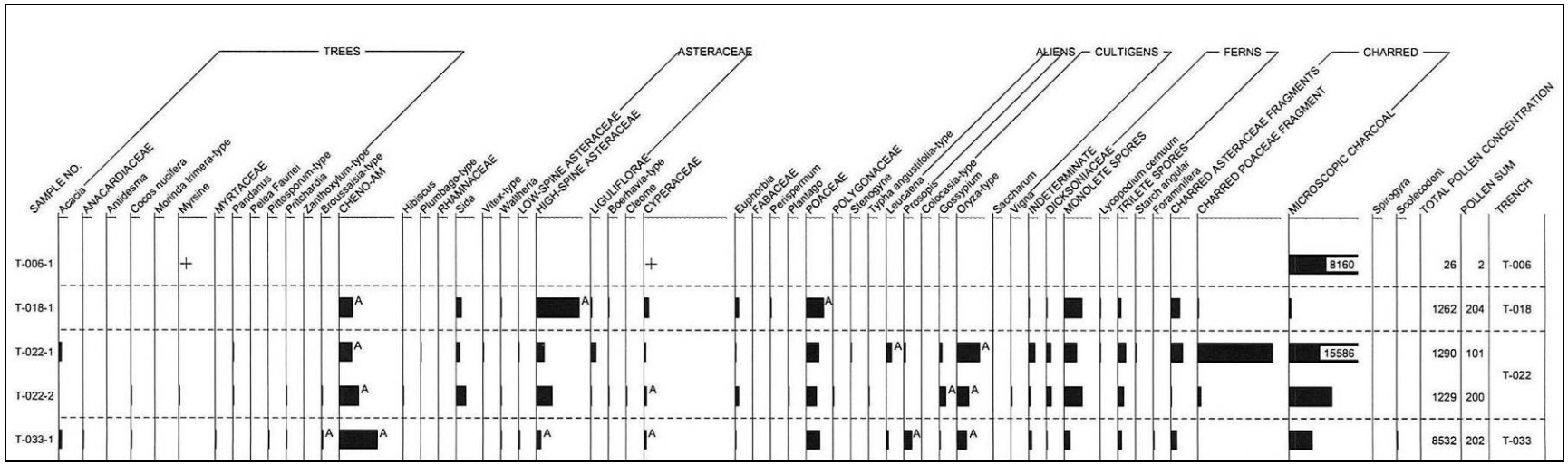
Plant names and information derived from (Wagner et al. 1990)

Fern (spore) names derived from (Selling 1946)

Nat = Naturalized (Adapted to a new environment and established as if native)
Pol = Polynesian introduction (Introduced to Hawai‘i by Polynesian voyagers)
End = Endemic (Evolved in Hawai‘i, found only in these islands)
Ind = Indigenous (Found natural in Hawai‘i but elsewhere as well)

“Pollen identifications to species were made based on the fact that only one species is reported by (Wagner et al. 1990). Species identification was not made based solely on morphologic characteristics observed under the microscope.” (Cummings and Varney 2012:18) (See Appendix F).

Table 16. Pollen Diagram for Airport Section 3 Test Excavations T-006, T-018, T-022 and T-033 (note: only the two samples from T-022 are superimposed and the presence of *Oryza*-type pollen suggests that the deeper sample may date to circa 1900)



Several relatively drought tolerant trees are indicated in the pollen record including *Pandanus tectorus* (*hala*), *Acacia* (*koai‘e*) and *Pritchardia* (*loulu*). Such pollen could have easily drifted south on the prevailing tradewinds and it remains unclear if they reflect a local community or a community significantly upwind. Macdonald et al. (1983:446), noting the presence of loulu palms and tree ferns buried standing up in air laid Salt Lake tuff, concluded that “the local climate at the time of the eruption was considerably wetter than it is now.” The uncertain time depth represented by the pollen and the dynamic environment add to the uncertainties but it does seem likely that a significantly more diverse plant community was present previously than modern conditions would suggest.

The only Polynesian-introduction indicated is coconut (*niu*, *Cocos nucifera*). Post-contact introductions indicated included:

•*Leucaena*

•*Prosopis*

•*Gossypium*, and

•*Oryza*-type pollen

The identification of *Oryza*-type pollen in T-022 and T-033 and of an “abundance of burned or charred Poaceae (grass) fragments, suggesting periodic burning of fields that probably contained rice” is noteworthy. Coulter and Chun (1937:21; see Table 17 and Figure 263) asserts that in 1892 there were 117 acres of Hālawa under rice cultivation and perhaps similar acreage under rice in Moanalua Ahupua‘a (the joint estimate of 150 acres in rice for Moanalua and Kalihi is given). Coulter and Chun (1937:20) cite Damon in an article in *The Friend* in 1882 as relating that “on O‘ahu the rice plantations began a few miles west of Honolulu and formed a fringe bordering the shore for a long distance ... Every available inch of ground seemed to be utilized” The burning of dried rice paddies after harvest could have led to the broadcasting of rice pollen on the trade winds.

Cummings and Varney (2012:4; see Appendix F) note the presence of “Gossypium-type pollen” in T-022 and T-033 “suggesting cultivating cotton in the area.” The simplest explanation for the relative abundance of “Gossypium-type pollen” is that it is from the native *Ma‘o* (*Gossypium tomentosum*), a wide-branched shrub that endures today as one of the most prominent large native shrubs to survive on the dry, southern coastal plain of O‘ahu. *Ma‘o* may well have been particularly abundant in the environs of the Airport Section 3 project area for millennia uncounted.

Cotton was an experimental industry of the Kingdom of Hawai‘i with Kamehameha I signing a contract regarding cotton exports in 1812 (Kuykendall Vol. I, 1968:86). In 1835, cotton cultivation was first on the list of missionary’s efforts to encourage “the development of industrious habits among the people…They pointed out that cotton grew well and that cotton cloth was in high demand among the people having nearly supplanted kapa for clothing” (Kuykendall Vol. I, 1968:174). Around 1831 or 1832, William French and a Mr. Reid sought “to hire a tract of land inland of the district of Ewa, O‘ahu. Their object was to cultivate cotton…” (Kuykendall Vol. I, 1968:174). There was a resurgence of cotton cultivation in Hawai‘i during the trade disruptions of the American Civil War. “In the summer of 1861, Judge John [Papa] Ii

Table 17. Rice Farming Districts on O‘ahu, 1892 (Acres) (from Coulter and Chun 1937:21)

TABLE III

Rice Farming Districts on Oahu, 1892

	Acres		Acres
Aiea and Kalauao	76	Mokuleia and vicinity	738
Halawa	117	Palama	200
Hautula	25	Palolo	102
Heeia and Kaneohe	200	Punaluu and vicinity	300
Honouliuli, etc.	147	Waialae	32
Kaalaea and Kahaluu	300	Waialua	180
Kahuku	50	Waiau, Manana and Waiawa	262
Kailua and Waimanalo	400	Waikane and vicinity	200
Kalihi and Moanalua	150	Waikele and Waipio	333
Kewalo and vicinity	75	Waikiki	542
Laie	45	Waimalu	135
		Other places	50
			4,659

Figure 263. Portion of Coulter and Chun’s (1937:12) map of “Rice Farming Districts on O‘ahu 1892” (Note: indications of rice cultivation in coastal Hālawa and a wide swath of Moanalua)

traveled over the islands distributing cotton seed (of the common variety) and induced many Hawaiians to try raising cotton." (Kuykendall Vol. II, 1982:174). Cotton was exported from the Kingdom through the period 1863-1874. John Papa ‘Ī‘ī was much associated with downtown Honolulu and his "Mililani" home (on Mililani Street) from whence he would often journey to his estates in Waipi‘o Ahupua‘a of ‘Ewa (modern Mililani being in the uplands of Waipi‘o). Each journey would have transited Moanalua and Hālawa twice. It would thus seem surprising if John Papa ‘Ī‘ī did not distribute cotton seed and induce Hawaiians to try raising cotton in Moanalua and Hālawa in 1861. Given ‘Ī‘ī's enthusiasm for cotton cultivation and his association with enterprise in the general region and the account of an earlier effort to pursue growing cotton in ‘Ewa (circa 1831-1832) we would not discount the possibility of "cultivating cotton in the area."

8.5 Charcoal Species Identification

The charcoal assemblage recovered from the Airport Section 3 test excavations were quite modest (see Table 18). The sample that was regarded as the best was sent to Ms. Gail Murakami at the International Archaeological Research Institute, Inc. for species identification. The purpose of the charcoal taxa identification was to aid in the selection of charcoal from relatively short-lived species prior to sending out the sample for carbon dating to avoid an inappropriately old date from the dating of "old wood." A charcoal sample was identified as from the native Hawaiian tree *Uhiuhi* (*Caesalpinia kavaiensis*) (Table 19 and Figure 264).

Uhiuhi is a shrub or tree about 4 to 10 m tall (Figure 264) associated with dry forest or mesic forest at an elevation of 80-920 m. Early Hawaiians made spears with the wood as well as a fishing implement known as *lā‘au melomelo* or *lā‘au mākālei* (Wagner et al. 1990:648). Fewer than fifty individual trees are known today (Wagner et al. 1990:648).

8.6 Carbon 14 Dating

Five small fractions of charcoal were recovered (see Table 18) and none of the samples were regarded as discrete features or other valid proveniences. A sample from T-031, on Ualena Street, west of Lagoon Drive, in a parking lot on the *makai* side, was sent for charcoal speciation and yielded an endemic species (*Uhiuhi*, *Caesalpinia kavaiensis*). This tree species is associated with higher elevations and suggest that the wood was possibly brought down to the coast for possible fishing uses such as a spear or a bait stick.

A relatively wide date range was recovered (Table 20) with multiple peak expressions (Figure 265). The charcoal may have been produced in late pre-Contact times (as early as AD 1660, but could have dated to as late as the early twentieth century). Given the great rarity of the tree today a date earlier in the range is suggested, but little can be said with certainty.

Table 18 Charcoal Samples Collected

Test Excavation #	Stratum	Depth (cmbs)	Weight (g)
T-018	III	240	<0.1
T-031*	If	23-26	0.5
T-032	II	89-107	<0.1
T-038	II	259-269	1.4
T-041	II	140-150	0.5

*charcoal sample identified to taxa and submitted for carbon dating

Table 19. Charcoal Taxa Identification in T-031

Provenience	WIDL No.	Taxa	Common/ Hawaiian Name	Origin/ Habit	Part	Count	Weight g
Ualena Street, west of Lagoon Drive, in parking lot on *makai* side	1302-1	*Caesalpinia kavaiensis*	*Uhiuhi*	Native/ Shrub-Tree	Wood	15	0.5

Figure 264. *Uhiuhi* (*Caesalpinia kavaiensis*), an endemic Hawaiian forest tree

Table 20. Results of AMS Radiocarbon Dating

CSH ID #	Beta Analytic ID #	Sample Material/ Analytic Technique	Provenience	Conventional Radiocarbon Age	C13/C12 Ratio	OxCal Calibrated Calendar Age (2 sigma)
H13T-031Id	Beta 342817	Charred wood material	T-031, Stratum Id 22-26 cmbs	140 +/-30 BP	-24.5 0/00	1660 – 1950 AD

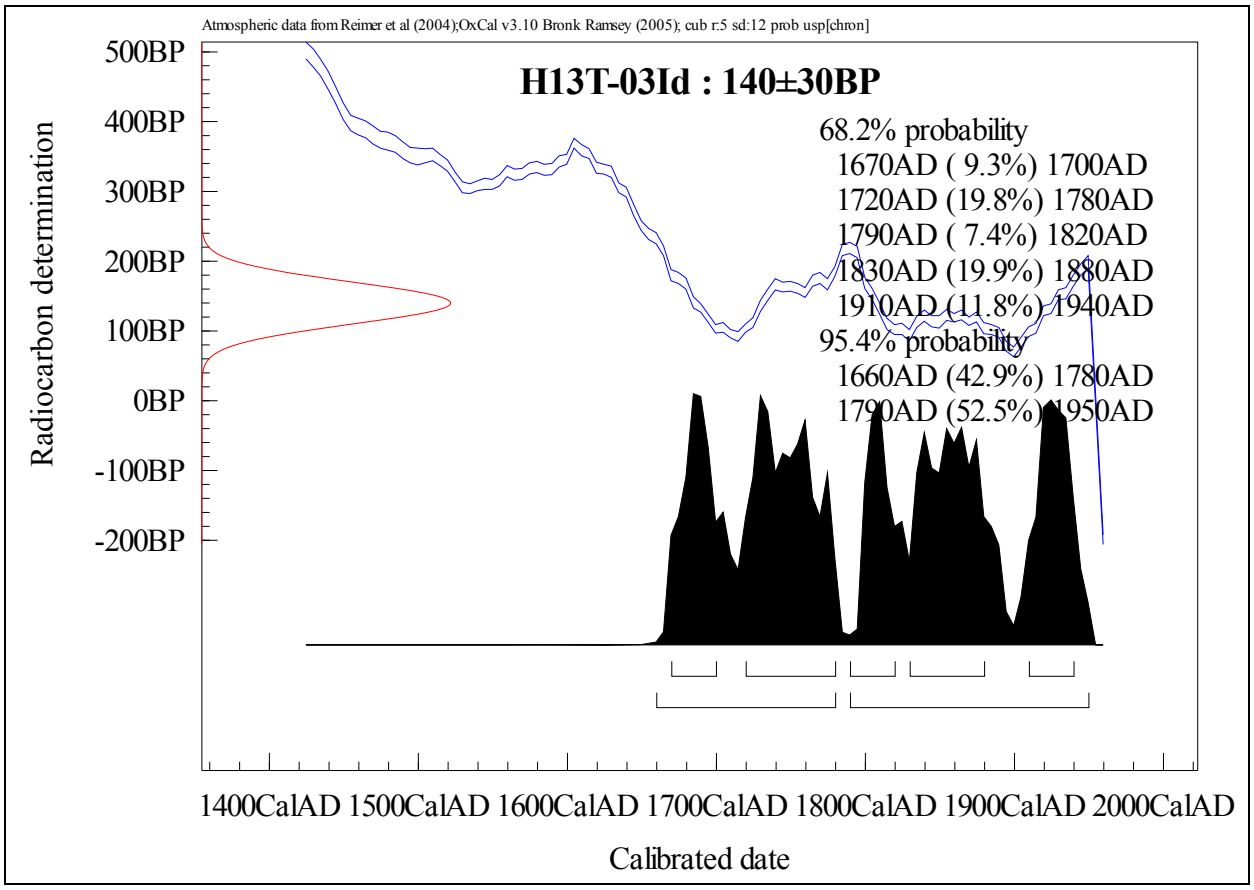


Figure 265. C14 Sample calibrated date graph for T-031 (Stratum Id 22-26 cmbs) *Uhiuhi* (*Caesalpinia kavaiensis)* charcoal